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(54) Title: VEHICLE PERFORMANCE MONITORING APPARATUS

(57) Abstract

A vehicle performance monitoring apparatus (20) for displaying the values of a plurality of performance parameters of a vehicle (10). The apparatus includes sensors (21, 22, 23, 24, 25) for sensing data indicative of the performance of the vehicle, processing means (40, 42) for processing this data to provide the parameter values, display means (35) for displaying said parameter values, and operator command means (37, 38) for controlling the operation of the apparatus including the selection of which performance parameter is to be displayed on the display means and the initiation of processing routines by the processing means. Additionally the apparatus includes mem ry means (43, 44, 45) for storing performance information relating to the performance parameters and th processing means (40, 42) is arranged in response to a predetermined operation of the operator command means (37, 38) to store in the memory means (43, 44, 45) a performance parameter value for each of a number of so-called relative mode parameters. These stored values are used as reference values so that subsequently, when the apparatus is perated in so-called relative mode, the current performance parameter values for the relative mode parameters are processed by the processing means (40, 42) and are each displayable on the display means (35) as proportions (e.g. percentages) of their respective reference value.
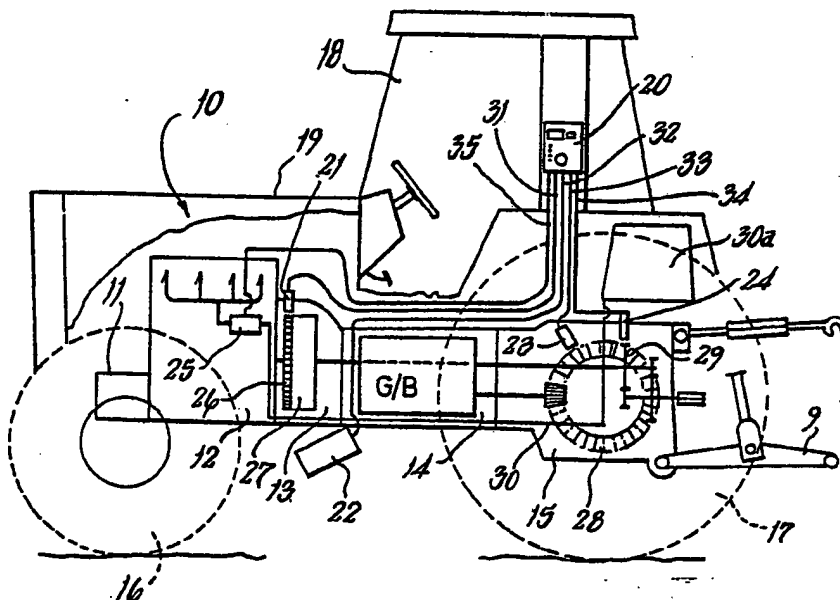
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## VEHICLE PERFORMANCE MONITORING APPARATUS

### Technical Field

This invention relates to vehicle performance monitors and
particularly, though not exclusively, to such monitors for
use in vehicles such as agricultural and industrial
tractors, combines and the like.

In the current environment of ever increasing vehicle
operating costs, there is an increasing requirement for the
provision of more detailed monitoring of vehicle operating
performance in order to enable the vehicle operator to
ensure a more cost effective operation of the vehicle.

### Disclosure of the Invention

It is an object of the present invention to provide an
improved form of vehicle performance monitor which is
particularly suitable for use in agricultural tractors and
like vehicles.

Thus according to the present invention there is provided a
vehicle performance monitoring apparatus for displaying the
values of a plurality of performance parameters of a
vehicle, said apparatus comprising sensing means for
sensing data indicative of the performance of the vehicle,
processing means for processing said data to provide said
parameter values, display means for displaying said
parameter values, and operator command means for controlling
the operation of the apparatus including the selection of
which performance parameter is to be displayed on the
display means and the initiation of processing routines by
the processing means, the apparatus being characterised by
including memory means for storing performance information
relating to said parameters and that said processing means
is arranged such that in response to a predetermined
operation of the op rator command means a p rformance
parameter value for  ach of a numb r of said parameters is
st r d in said m mory means as a ref rence value s  that
subsegu ntly, when the apparatus is op rated in a relative

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mode, th current performance values for said one r mor
parameters (hereinafter referred to as the relative mode
parameters) are processed by said processing means and are
displayable on said display means as proportions of their
respective reference values.

It is envisaged that the stored reference values will be
generated by the processing means in response to the
predetermined operation of the operator command means by
taking the average value of the performance data coming from
the appropriate sensors over a time period of say two
seconds. This will guard against spurious readings due to
short duration fluctuations in the data coming from the
sensors.

The memory means may conveniently include memory locations
(hereinafter referred to as the reference table memory
locations) in which the last generated/current reference
values of the relative mode parameters are stored and
separate memory locations (hereinafter referred to as the
scratch table memory locations) where performance parameter
data on the relative mode parameters is accumulated or
temporarily stored during the generation of a new set of
reference values.

In a preferred arrangement in order for the operator to
initiate the generation of a new set of reference valves he
is required to continuously maintain a given operation of
the command means (e.g. hold down a button) for a
significant initiating time period of say two seconds to
prevent accidental generation of new reference values. Thus
to gen rate new referenc values the operator operates th
command means for two sec nds and at th end f this two
second period provided th operator continu s to operate the
command means, the apparatus commenc s th gen ration f th

n w refer nce values by sampling th  sensors ov r the n xt
two second period to generate the average values of the
relative mode parameters.  Thus the entire generation of the
new reference values takes four seconds at the end of this
time the new reference values are copied into the reference
table memory locations for future use.

As will be clear from the above, if the operator releases
the command means before completion of the above four
second period generation of new reference values is either
not commenced or if commenced not completed.  In either
event, as will be discussed in greater detail below, the
apparatus will continue to use the previously generated
reference values.

Conveniently, the monitoring apparatus can be configured so
that immediately the regeneration of new reference values
has been completed the apparatus automatically operates in
the relative mode.  The apparatus is switchable by the
operator command means between the relative mode in which
the current values of the relative mode parameters are
displayable relative to the reference values (for example as
percentages) and the normal mode in which the actual current
values of all the displayable parameters are displayable.

In a typical installation in accordance with the present
invention applied to on agricultural tractor, examples of
relative mode performance parameters are:-

> Vehicle Speed
> Fuel/Area Worked
> Fuel/Hour
> Area Work d/Hour
> Engin  Sp  d
> PTO Sp  d

Thus if, for example, an operator is using an agricultural
tractor in a field and wishes to know the effect on one or
more of the above listed relative mode parameters of say a
change in throttle opening or gear ratio,the operator
would:-

1.  Make said predetermined operation of the operator
    command means to store reference values for the relative
    mode parameters in said memory means.

2.  Change the throttle setting or gear ratio as desired.

3.  View the current values of the relative mode parameters
    on the display means in the relative mode.  These
    current values will be displayed as proportions (e.g.
    percentages) of the reference values.

Thus if, for example, the effect of the change in throttle
opening and/or gear ratio was to increase fuel
comsumption/hour by say 5% the display means would display
"r 105" if the fuel/hour parameter was selected for display
by the operator.  [The "r" indicating and warning that the
apparatus is operating in the relative mode].  Clearly such
information is an invaluable tool to the operator in
ensuring the economical operation of the tractor.

Description of the Drawings

One embodiment of the present invention as applied to a
monitoring apparatus for use on an agricultural tractor will
now be described, by way of example only, with reference to
the accompanying drawings in which:-

    Figure 1 is a diagrammatic repr sentation of an
    agricultural tractor fitted with a monitoring apparatus
    in acc rdance with the pres nt invention;

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Figure 2 is an exterior view on a larger scale of the
main unit of the monitoring apparatus;

Figure 3 is a block diagram of the hardware of the main
unit;

Figure 4 is a flow diagram showing the logic loops used
in the recalculation of reference values for the relative
mode performance parameters, and

Figure 5 is a diagrammatic representation on a time basis
of the operating sequence of various parts of the
monitoring apparatus.

Referring to Figure 1, the tractor 10 comprises a chassis
built up from a series arrangement of castings constituted
by a front axle support 11, an engine block 12, a clutch
housing 13, a gearbox housing 14 and a back axle housing 15.
The chassis is supported on front and rear wheels 16 and 17
respectively and carries a cab 18, an engine hood 19 and a
rear three-point hitch 9 controlled by a hitch control
system (not shown).

The monitoring apparatus comprises a main unit 20 and a
number of performance sensors 21 to 25.  In the example
illustrated, the main unit 20 is mounted on the inside of
one of the vertical cab posts, but it will be appreciated
that the unit 20 could be mounted in any location convenient
for the tractor operator.

In the particular example to be described the sensors
provide data directly indicative of the following factors:-

Sensor Unit                     Factor

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| 21 | Engine Speed |
|---|---|
| 22 | Actual Vehicle Speed |
| 23 | Theoretical Vehicle Speed |
| 24 | PTO Speed |
| 25 | Fuel Flow Rate. |

Although the actual type of sensor used forms no part of the
present invention, examples  of suitable sensors will now be
briefly discussed.

Sensor 21 is of the electro-magnetic type and is located
adjacent the teeth 26 on the starter ring of the
flywheel/clutch unit 27 so that as the teeth 26 pass the
sensor a signal is generated by the sensor whose frequency
is proportional to the speed of rotation of the flywheel and
hence the engine speed.

Sensor 22 a is Doppler radar unit whose beam is directed in
a downwardly sloping attitude and which provides a signal
whose frequency is proportional to the actual speed of the
vehicle over the ground in the known.manner.

Sensors 23 and 24 are of a similar electro-magnetic type to
sensor 21 and are respectively associated with crownwheel
teeth 28 and PTO drive gear teeth 29 thus respectively
providing signals proportional to the actual speed of
rotation of the r ar driving wh els 17 (i.e. proportional to
the theoretical speed of the vehicle) and the PTO shaft
rotational spe d.

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Fuel flow sensor 25 is of the electro-magnetic type in which
the speed of rotation of a small turbine element disposed in
the fuel line 30 from a fuel tank 30a is measured to provide
signals proportional to the fuel flow rate.  Alternatively,
in diesel engine applications the speed of movement of
various parts of the diesel fuel injector pump can be
monitored to provide signals proportional to fuel flow rate.

The sensors 21 to 25 are connected with the main unit 20 via
lines 31 to 35 respectively.  An external view of the main
unit 20 is shown on a larger scale in Figure 2.

Externally the unit 20 has a display means in the form of a
four digit LCD display 35 and a vertical array
of LED's 36 each with its own caption to indicate the
performance parameter being displayed on the LCD display.
Figure 2 shows a typical selection of the parameters which
might be monitored in an agricultural tractor application.

The unit is provided with operator command means in the form
of a reset button 37 and rotary knob 38.  The button 37 and
knob 38 constitute multi-function controls for the
monitoring apparatus which, in addition to the functions
which will be described below in relation to the present
invention, also allow the operator to perform other
functions such as:-

1)   Resetting the accumulated data on a given displayed
     parameter to zero or any other positive value.

2)   Setting a given performance reference value to be used
     as a warning threshold on certain parameters (e.g. a
     level of slip above which a warning should be given or
     corrective action taken).

3)  Inputting data (e.g. implement width) required in
    calculations made by the monitoring apparatus to
    calculate certain displayed parameters (e.g. Fuel/Area
    worked).

The hardware of the main unit 20 is shown diagrammatically
in Figure 3 and is largely self-explanatory.
At the heart of the unit is the processing means constituted
by a microprocessor 40 and its associated PROM 42.
Processor 40 communicates with PROM 42 and RAM 43 via bus
41.  RAM 43, as will be referred to later below, includes
reference table memory  locations 44 and scratch table
memory locations 45.

Processor 40 also communicates via bus 46 with as sensor
interface 47 which converts the signals coming from sensors
21 to 24 into signals which can be read and processed by the
processor 40.  The reset button 37 and control 38 are shown
diagrammatically in Figure 3 as the switch inputs box 48.

The LCD display output 35 and LED indicator lights 36 are
shown diagrammatically in Figure 3 by output box 50 which
communicates with processor 40 via bus 49.

The hardware of the performance monitor is completed by the
power supply 53 which has tappings for a variety of voltages
required by different parts of the circuity of the monitor.

In the particular version of the tractor performance monitor
being described the following relative mode performance
parameters are implem nted:-

                    Vehicle Speed
                    Fuel/Ar a Worked

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Fuel/Hour
Area Worked/Hour
Engine Speed
PTO Speed

As will be evident, these relative mode parameters (and
indeed the non-relative mode parameters) are basically of
two types.  A first type in which a sensor provides a signal
which is proportional to the parameter to be displayed (e.g.
vehicle speed and PTO speed) and the processing means does
no more than turn the sensor signals into displayable
readings and a second type in which the processing means is
also called upon to do some mathematical calculation and/or
operate on more than one sensor signal [e.g. "fuel/area
worked" where the processing means in addition to providing
a fuel comsumption figure is also called upon to calculate
the area worked from the data indicating the distance
travelled- (derived from the signal from radar unit 22) and
the width of the implement being used (which is an operator
input as referred to briefly above)].

Another  example of a performance parameter which requires
the processing means to operate on more than one sensor
signal and perform mathematical calculations is the wheel
slip parameter which requires the processing means to
perform calculations on the actual vehicle speed and the
theoretical vehicle speed signals in the known manner to
provide, for example, a percentage wheel slip display
capability.

Operation of a tractor performance monitor of the form
described above will now b  described with reference to
Figures 4 and 5.

Assuming that the tractor is b ing operated in a field and

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the operator wishes to know the effect of changing, for
example, the engine throttle setting on the relative mode
performance parameters the operator would ensure that the
currently stored reference values reflect the current
operating conditions of the tractor by undertaking the
following procedure.


Firstly, the selector knob 38 is rotated clockwise or anti-
clockwise to ensure that the monitor is displaying one of
the six relative mode performance parameters itemieed above.
The operator then depresses the reset button 37.  For the
first two seconds of the depression of the reset button 37
the LCD display 35 goes blank.  This is a waiting/decision
period to ensure that the operator really does require the
tractor performance monitor to go through a recalculation
process for the reference values of the six relative mode
parameters.

Assuming that the operator continues to depress the reset
button after the two second decision period the
recalculation of the reference values is initiated and the
LCD display displays a chosen predetermined warning display
(for example, "rrrr") to indicate that this recalculation is
in progress.  The recalculation process takes two seconds
and at the end of this two second period, that is four
seconds from the initial depress of the reset buttom 37, the
LCD display automatically begins to display the
instantaneous values of the currently selected performance
parameter (indicated by the operative LED) as a percentage
of the recalculated reference value.  The initial display on
LCD display 37 immediat ly after recalculation of th
reference valu s is "r100".  The "r" warns that the relative
mode is operativ  and the "100" indicates that the current
paramet r value is the same as the new ref r nce value.

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The operator now makes the required change to the throttle
setting and assuming that the operator has selected the
Fuel/Hour parameter for display and the effect of the change
in throttle setting is to worsen the fuel consumption per
hour by say 5%, the LCD display 35 will display the reading
"r 105" after the throttle setting change has been made.  If
the operator wishes to view the effect of the change in
throttle setting on any of the other five relative mode
parameters the operator simply turns knob 38 to switch to
the required relative mode parameter to obtain a relative
mode percentage display.

The operator is free to switch between the relative mode
display in which the current values of the six relative mode
parameters are displayable as percentages of the reference
values currently stored in the reference table memory
locations as described above and the normal mode in which
the actual current values of all the displayable parameters
of the tractor performance monitor are displayable on the
LCD display.  This switching between the relative and normal
modes is achieved by simply depressing the reset button 37
and releasing this button within the initial two second
decision period described above. Each such brief depression
of the reset button 37 switches from one mode to the other.

Figure 4 shows one form of logic diagram suitable for use
in the recalculation if reference values in a monitoring
system in accordance with the present invention.  Referring
to Figure 4, it will be observed that this provides a logic
loop 100 which is executed every half a second.  This time
period is chosen to correspond with the time period for
updating of the LCD display 35 which is also half a second
in the exampl  chosen.

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When the system is recalculating the referenc values for
the six relative mode parameters (see box C in Figure 4) it
is arranged to do so by calculating the average value of
each of the six parameters over the two second recalculation
period. Since the logic loop of Figure 4 is executed every
half a second the system in practice calculates the average
value of each parameter for four consecutive half-second
periods and then averages these four consecutive average
values.

During the recalculation of the reference values,
performance data on the relative mode parameters is
accumulated/temporarily stored in the scratch table memory
locations 45 at the end of the two second recalculation
period the new reference values for the relative mode
parameters are transfered from the scratch table memory
locations 45 to the reference table memory locations 44 for
subsequent use when displaying the parameters in the
relative mode (see box D of Figure 4).

If the recalculation of the reference values is not
successfully completed as a result of the operator removing
his finger from the reset button 37 before the 4 second
period is complete, the system is configured to ensure that
the reference values stored in the reference table memory
locations before the reset button was pressed are maintained
in the reference table memory locations for future use.

This is achieved by the simple expedient of arranging that
at the end of each successful or unsuccessful attempt to
recalculate new reference values for the relative mode
param t rs the valu s in th  scratch table memory locations
are always copied into the reference table memory locatior
(see box D in Figure 4) and in the  vent of an unsuccessful
attempt to recalculate n w reference values immediately

prior to the above step of box D, the reference table values
are copied into the scratch table memory locations (see box
E of Figure 4).

Decision box A of Figure 4 relates to the depression of
reset button 37 to initiate a recalculation of the reference
values of the relative mode parameters. Thus until the
initial two second decision period has passed, that is until
the fifth time round loop 100, the logic loop will exit from
box A via the "NO" branch 101. On the fifth time round loop
100 the logic loop will exit from box A via the "YES" branch
102 to initiate recalculation of the reference values (see
box C).

When the recalculation of the reference values is complete
in the scratch table memory locations a "done" flag is set
in the microprocessor and the next time round loop 100 the
logic loop exits from box A via "NO" branch 101 to decision
box B.

Box B relates to the successful recalculation of new
reference values. Thus following the setting of a "done"
flag the logic loop exits from box B via "YES" branch 103 so
that the new reference values are transferred from the
scratch table memory locations 45 into the reference table
memory locations 44 (see box D).

When the logic loop exits from box B via the "NO" branch
104, which will occur should the operator release the reset
button before the end of the four second period required to
complete the recalculation of the reference values, the
current values in the reference table memory locations 44
are copied into the scratch table memory locations 45 (see
box E) and these reference values ar  then copi d back into
the reference table memory locations 44 (s e box D) to

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ensure that the original reference values are maintained as
described earlier above.

Figure 5 shows diagrammatically on a time basis the
operating sequence for the reset button 37, the LCD display
35, the activity of microprocessor 40, and the status of the
reference values in memory locations 44.

It will be appreciated from the above that the present
invention provides an improved form of vehicle performance
monitor which has the ability to store performance paramater
values for the relative mode parameters and then to display
the current performance parameter values as proportions of
their respective reference values.  This relative mode
feature provides the operator with a particularly clear
indication of the effect on the vehicle performance of
changes in the vehicle operating settings.

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## CLAIMS

1. A vehicle performance monitoring apparatus (20) for
   displaying the values of a plurality of performance
   parameters of a vehicle (10), said apparatus comprising
   sensing means (21,22,23,24,25) means for sensing data
   indicative of the performance of the vehicle, processing
   means (4),42) for processing said data to provide said
   parameter values, display means (35) for displaying said
   parameter values, and operator command means (37,38) for
   controlling the operation of the apparatus including the
   selection of which performance parameter is to be
   displayed on the display means and the initiation of
   processing routines by the processing means, the
   apparatus being characterised by including memory means
   (43,44,45) for storing performance information relating
   to said parameters and that said processing means (40,42)
   is arranged so that in response to a predetermined
   operation of the operator command means (37,38) a
   performance parameter value for each of a number of said
   parameters is stored in said memory means (43,44,45) as a
   reference value so that subsequently, when the apparatus
   is operated in a relative mode, the current performance
   parameter values for said one or more parameters
   (hereinafter referred to as the relative mode parameters)
   are processed by said processing means (40,42) and are
   displayable on said display means (35) as proportions of
   their respective reference values.

2. An apparatus according to claim 1 characterised in that
   the stored reference values are generated by the
   processing means (40,42) taking the average value of the
   performanc data coming from the appropriate sensors
   (21,22,23,24,25) over a predetermined time period.

3. An apparatus according to claim 1 or 2 characterised in

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that the memory means (43,44,45) includes reference table
memory locations (44) in which the last generated or
current reference values of the relative mode parameters
are stored and separate scratch table memory locations
(45) where performance parameter data on relative mode
parameters is accumulated or temporarily stored during
the generation of a new set of reference values.

4. An apparatus according to any one of claims 1 to 3
characterised in that in order to initiate generation of
new reference values an operator must continuously
maintain a given operation of the command means (37) for
a significant initiating time period.

5. An apparatus according to claim 4 characterised in that
in order to complete generation of new reference values
the operator must continue to maintain said given
operation of the command means (37) for a predetermined
generation period after the end of the initiating time
period.

6. An apparatus according to any one of claims 1 to 5
characterised in that immediately after the completion of
the regeneration of new reference values the apparatus
automatically operates in the relative mode.

7. An apparatus according to any one of claims 1 to 6
characterised in that the display means (35) displays a
predetermined warning display (rrrr) during generation of
a new set of reference values.

8. An apparatus according to any one of claims 1 to 7
characterised in that the display m ans (35) displays a
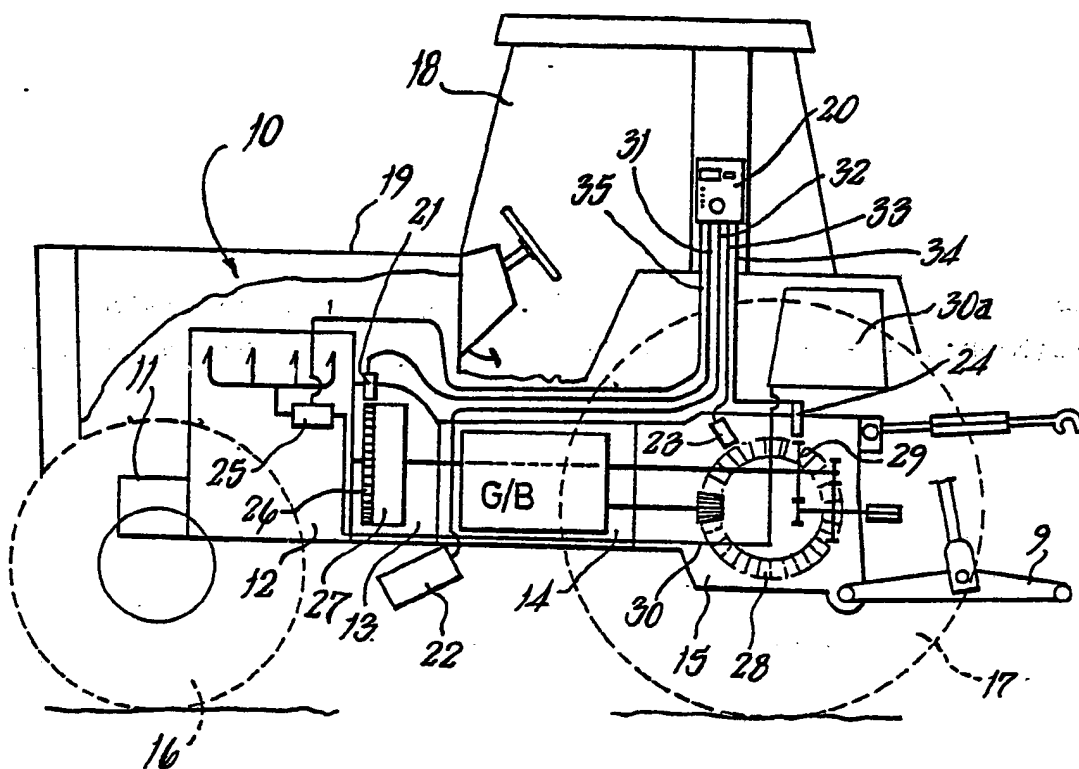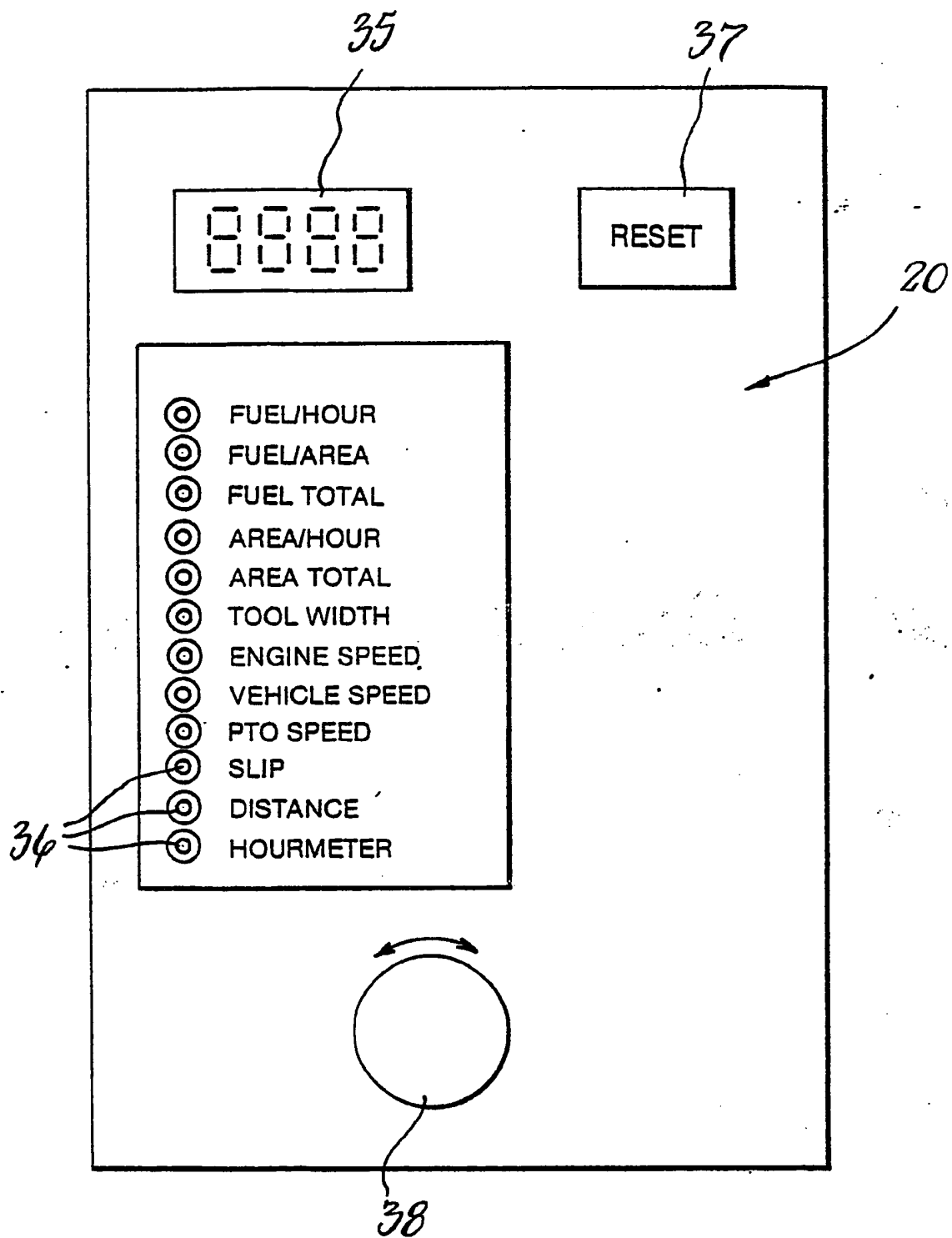warning symbol (r) when displaying a performance
paramet r in the relative mode.

FIG.1

FIG.2

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FIG.3

4/5

FIG.4

```
┌─────────────────────────┐
│   INITIALISE HARDWARE   │
│   START SENSOR SAMPLER  │
│     ENABLE INTERRUPTS   │
└─────────────────────────┘
             │
             ▼
      ┌──────────────┐
      │   WAIT FOR   │
      │ 0.5 SEC CLOCK│
      └──────────────┘
             │      ╌╌╌ 100
             ▼
┌─────────────────────────┐
│   PROCESS SENSOR DATA   │
│   CLEAR SAMPLER MEMORY  │
│  CALCULATE ALL PARAMETERS│
└─────────────────────────┘
             │
             ▼
      A    ◇ RECALC ◇         102
        ◇ OF REFERENCE ◇  YES
        ◇   VALUES     ◇──────►
          ◇ INITIATED ◇
             │
             NO
             │   101
             ▼
      B    ◇ RECALC ◇
    NO  ◇ COMPLETED ◇
   ◄────◇           ◇
  104 │              │
      E              YES
┌──────────────┐    │  103
│COPY REFERENCE│    │
│   TABLE TO   │    ▼
│ SCRATCH TABLE│    D
└──────────────┘
```

AVERAGE EACH RELATIVE
MODE PARAMETER FOR
2 SECONDS (SIMULTANEOUSLY)
USE SCRATCH TABLE
FOR RESULTS.
SET "DONE" FLAG
WHEN COMPLETE

C

COPY SCRATCH
TABLE TO
REFERENCE TABLE

5/5

TIME SECS ⟶

```
        0         1         2         3         4
```

RESET
BUTTON          DEPRESSED                              ⟋⟍↑ RELEASED
CONDITION

LCD                                                        DISPLAYS
DISPLAY   ⟵— BLANK DISPLAY —⟶⟵— DISPLAYS "m" —⟶         SELECTED
                                                           PARAMETER IN  ⟋↘
                                                           RELATIVE MODE
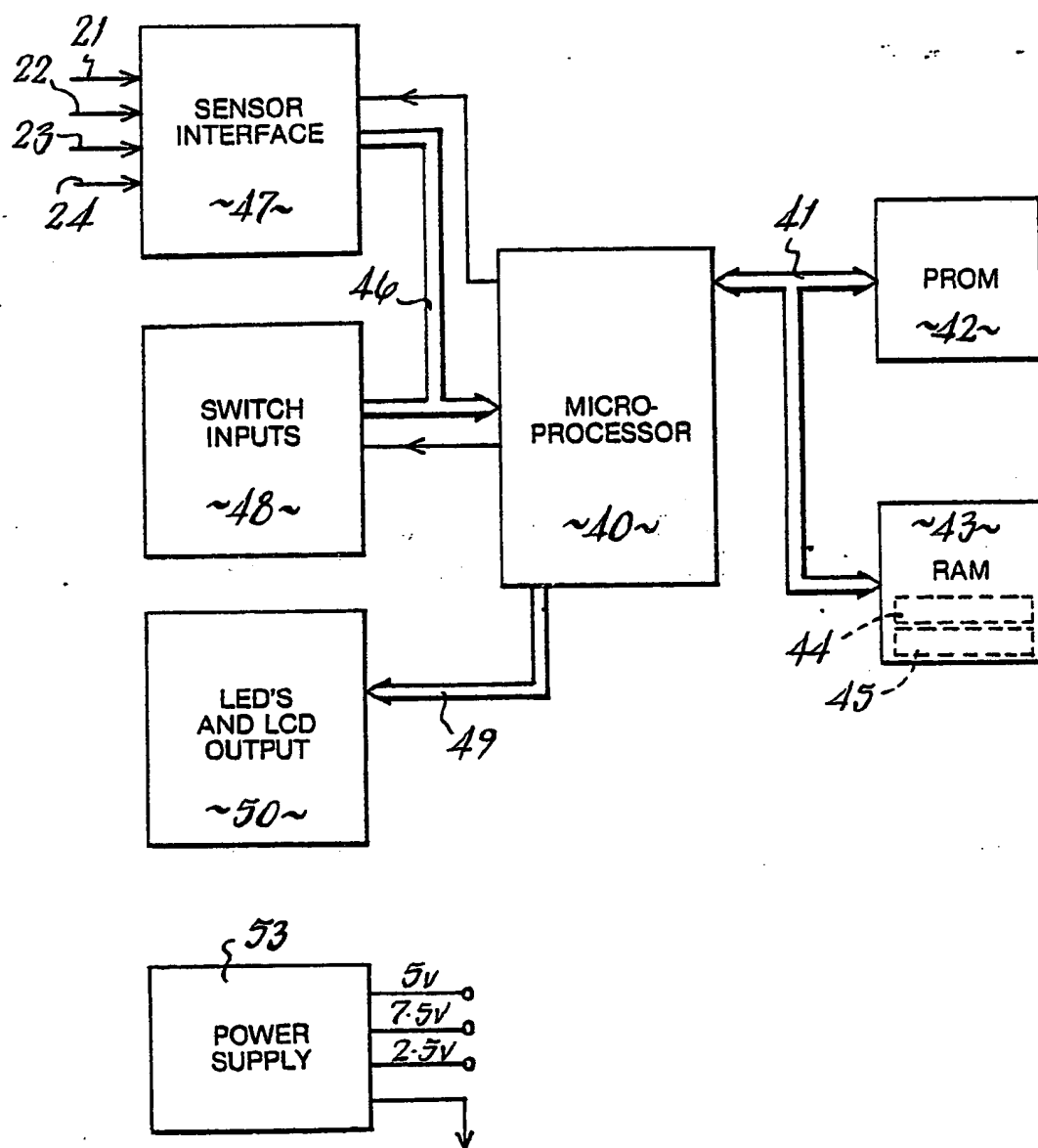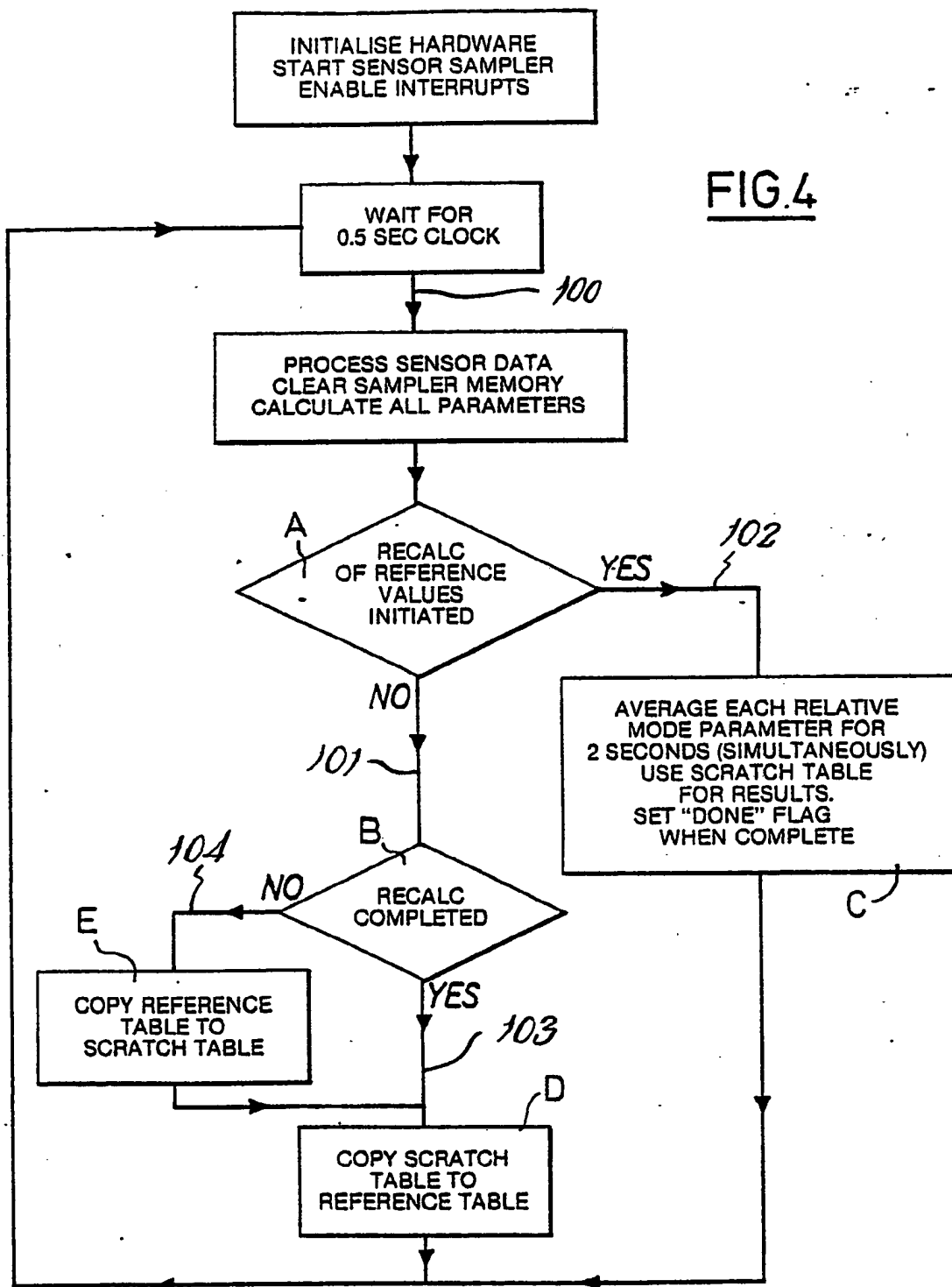                                                           e.g. "r105"

PROCESSOR ⟵   WAITS FOR END      ⟶⟵  COMPUTES        ⟶
ACTIVITY      OF 2 SECOND            NEW REFERENCE
              DECISION PERIOD        VALUES IN
                                     SCRATCH TABLE

REFERENCE ⟵   OLD          ⟶⟵    OLD           ⟶      NEW VALUES
VALUES        VALUES            VALUES                 COPIED FROM  ⟋↘
              HELD             HELD                    SCRATCH TABLE
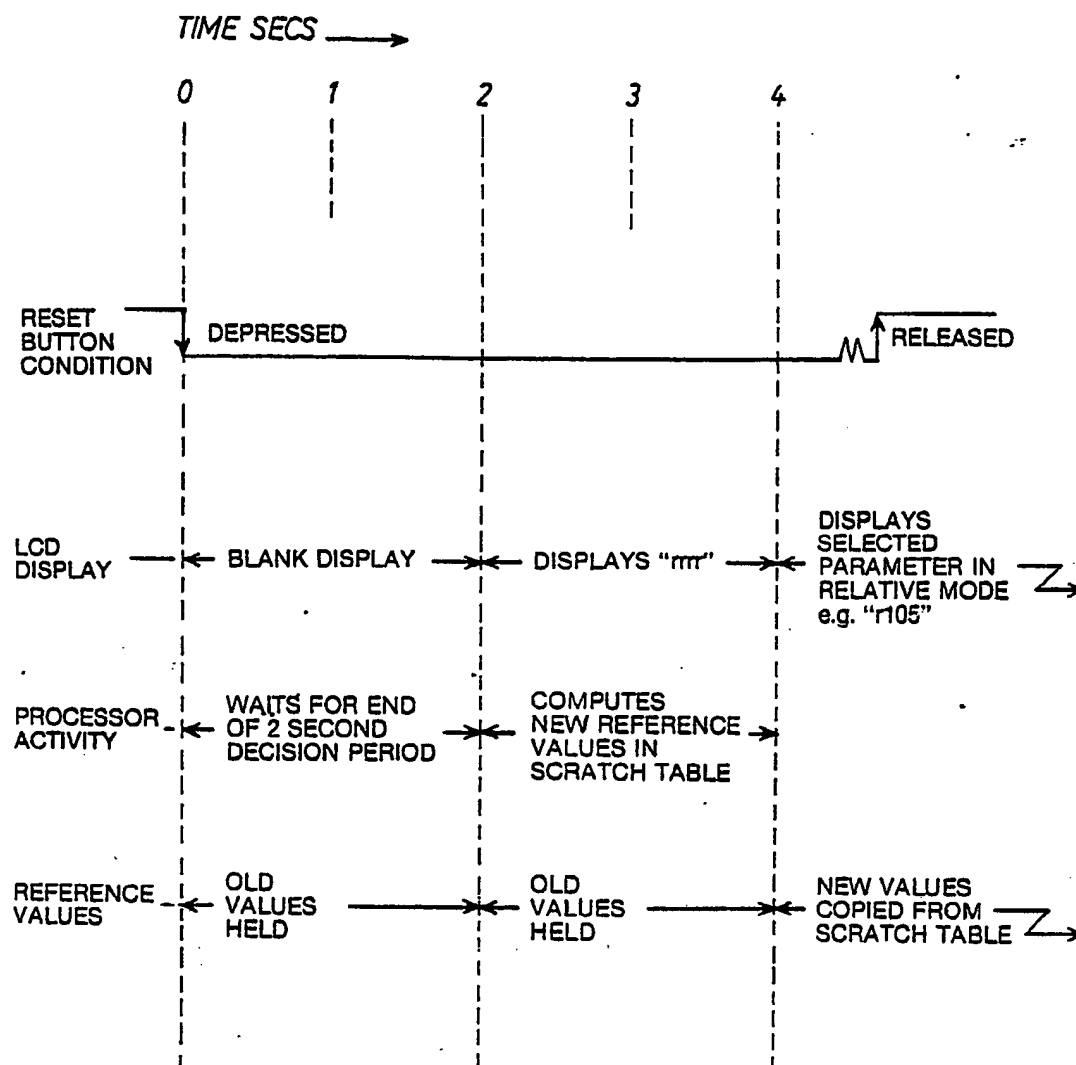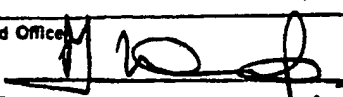
<u>FIG.5</u>

# INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 86/00197

## I. CLASSIFICATION F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: G 07 C 5/10; B 60 Q 9/00

## II. FIELDS SEARCHED

### Minimum Documentation Searched [7]

| Classification System | Classification Symbols |
|---|---|
| IPC[4] | G 07 C; B 60 Q; G 06 F |

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched [8]

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

| Category [*] | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No. [13] |
|---|---|---|
| Y | WO, A, 82/01354 (MASSEY-FERGUSON) 29 April 1982, see page 7, line 29 – page 12, line 2; page 13, line 25 – page 14, line 10; page 19, line 27 – page 20, line 10; page 25, line 5 – page 26, line 14; claims; figures | 1 |
| A | | 2-4 |
|  | -- | |
| Y | US, A, 4140996 (LEITCH et al.) 20 February 1979, see abstract; column 4, lines 29-42; claims; figures | 1 |
| A | | 8 |
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| A | US, A, 4419654 (FUNK) 6 December 1963, see abstract; column 1, line 64 – column 2, lines 35,51 – column 4, line 66; figures | 1 |
|  | -- | |
| A | EP, A, 0114018 (RENAULT) 25 July 1984, see claims; figures | 1,2 |
|  | -- | |
| A | US, A, 4296409 (WHITAKER) 20 October 1981, see abstract; figures | 1,4 ./. |

* Special categories of cited documents: [10]
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

## IV. CERTIFICATI N

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 3rd July 1986 | 3 1 JUL 1986 |

| International Searching Authority | Signature of Authorized Officer |
|---|---|
| EUROPEAN PATENT OFFICE | M. VAN MOL |

Form PCT/ISA/210 (second sheet) (January 1985)

| Category * | Citation of Document, with indication, where appropriate, of the relevant passages | Relevant to Claim No |
|---|---|---|
| A | US, A, 4344136 (PANIK) 10 August 1982 | |
| A | GB, A, 2002703 (BMW) 28 February 1979 | |
| A | US, A, 4013875 (McGLYNN) 22 March 1977 | |

**III. DOCUMENTS CONSIDERED TO BE RELEVANT    (CONTINUED FROM THE SECOND SHEET)**

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This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 18/07/86

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| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
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| WO-A- 8201354 | 29/04/82 | EP-A-<br>AU-A-<br>CA-A- | 0070833<br>7647481<br>1180430 | 09/02/83<br>11/05/82<br>01/01/85 |
| US-A- 4140996 | 20/02/79 | None | | |
| US-A- 4419654 | 06/12/83 | None | | |
| EP-A- 0114018 | 25/07/84 | JP-A- | 59128413 | 24/07/84 |
| US-A- 4296409 | 20/10/81 | None | | |
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